Product Development For Future Satellite Missions

Tony Burunoff
METSAT Conference
April 27, 2009

SeaSpace Corporation in Poway, CA

1. Introduction to SeaSpace
2. Current and Future Direction of SeaSpace
3. New Products
4. Current and Future Environmental Satellites

Company Background

- Established in 1982
- Dedicated to the science and practice of weather and ocean remote sensing
- 38 employees
- 66% comprised of skilled technical and PhD-level scientists
- Acquired by Sung Hong 2007

Company Background

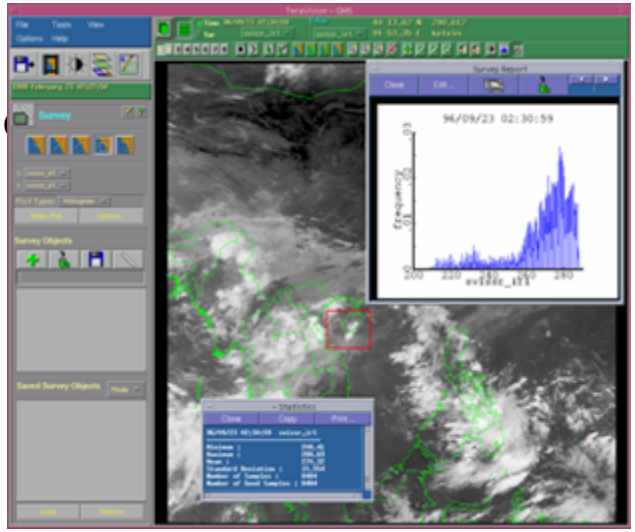
- COTS Product Name **TeraScan®**

- Hardware and Industry Standard Software products for receipt, processing, display and routing of real-time Meteorological, and Environmental Data
- User base: 50% science and research, 30% civilian operational, 20% military
- TeraScan® systems are now operated in 35+ countries by over 400 customers

SeaSpace's World Customer Base

TeraScan Products

- **TeraScan Hardware System Components:**
  - **Antennas (geostationary, tracking antennas protected in radomes)**
  - **Receivers (single or dual feeds)**
  - **Linux based for more stability and se**



- **TeraScan Software Modules:**
  - **Acquisition Control**
  - **Post-Processing**
  - **Visualization**
  - **Automatic product generation & delivery**
  - **Similar software interface for all telemetries**

Long-term Relationships

SeaSpace's 26 years of experience has led to research and development partnerships with

- **NOAA & the National Weather Service**
- **NASA**
- **European Space Agency**
- **China National Space Administration**
- **Japan Aerospace Exploration Agency**
- **Antrix: Indian Space Agency's commercial division**
- **German Aerospace Center (DLR)**

These relationships allow SeaSpace to serve our customers better through state-of-the-art software development and planning for future missions.

Additional Capabilities

Customer Support

- A dedicated staff of 7 project engineers & support technicians
- A 24 x 7 x 365 Data Operations Center – providing products globally
- An international network supporting installations, maintenance and on-site support

- **TeraScan®** Operations and Maintenance Training
- Satellite Meteorology Training
- Satellite Oceanography Training
- Basic and Advanced Remote Sensing Training
- International User Conferences

Current Direction

- **Company-Wide Focus**
- Intellectual Growth
- Experienced Customer Support
- Investment in Software Development
- Reduce Production Cycle

CUSTOMER SATISFACTION

Current Direction

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- **Intellectual Growth**
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38 Full Time Employees

Current Direction

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Tony Burunoff

Catherine Brambila

Dedicated Support Team

Current Direction

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Improve TeraScan® Software - Enhanc Capability

Current Direction

- Company-Wide Focus
- Intellectual Growth
- Experienced Customer Support
- Investment in Software Developm
- **Reduce Production Cycle**

Increase Inventory
Make Essential
Parts Available

Future Direction

- Customer Collaboration
- Support New Missions
- Data Distribution
- Bring Science Back to SeaSpace
- New Development

Important to Deliver the Right Product to the End-User

Future Direction

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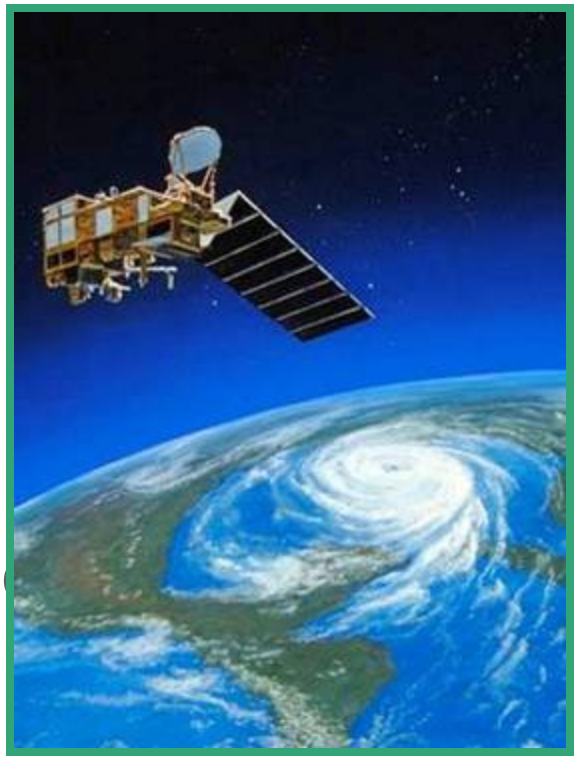


GOES-R METOP OCM-2
NPP/NPOESS
And Beyond

Future Direction

- Customer Collaboration
- Support New Missions
- Data Distribution
- Bring Science Back to SeaSpac
- New Development

Generate Data and Products Easily Accessible

Future Direction

- Customer Collaborati
- Support New Mission
- Data Distribution
- **Bring Science Back to SeaSpace**
- New Development

Add Value to TeraScan® and Products

Future Direction

- Customer Collaborati
- Support New Mission
- Data Distribution
- Bring Science Back to SeaSpac
- **New Development**

Hardware and Software Systems to Meet New Requirements

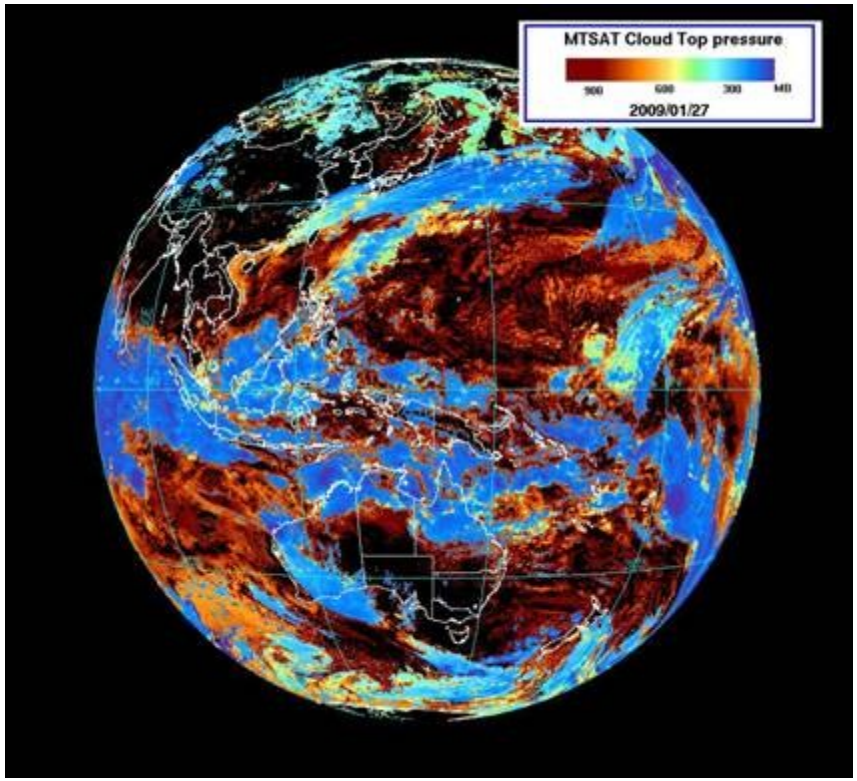
New Products at SeaSpace Corporation

TeraScan Software Release

- Currently in Q/A
- Beta Testing in May
- Mid-June Release
- Supports CentOS/RHEL 4.x

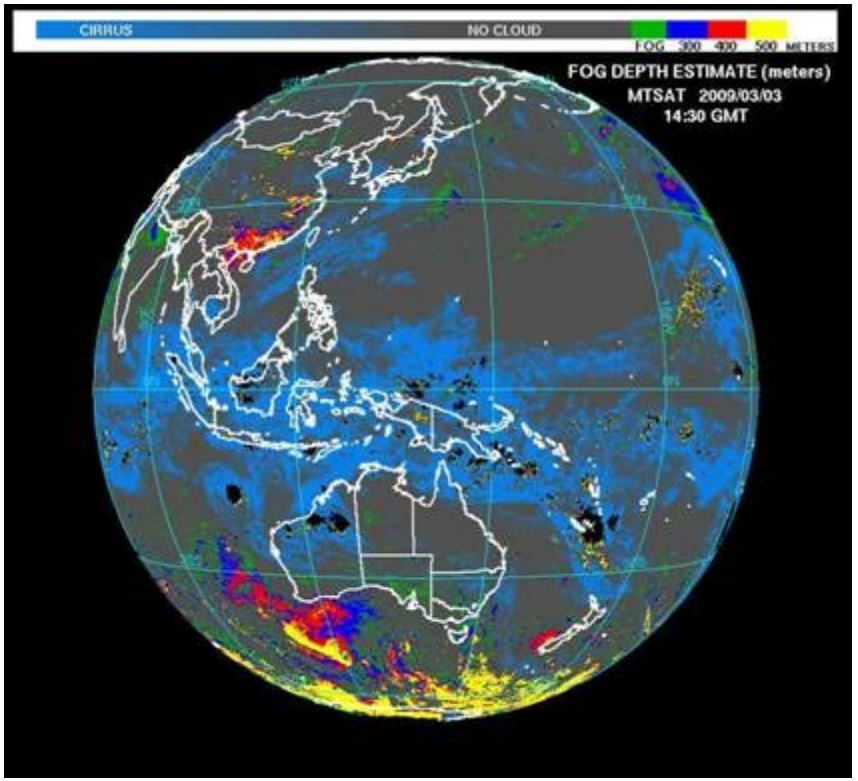
Cloud Products

- Updated cloud product generation for GOES, MSG & MTSAT
  - Cloud top altitudes
  - Cloud top pressure
  - Cloud top temperature
  - Cloud types
  - Cloud precipitable water content
  - Cloud effective radius values
  - Water vapor channel estimated heights
  - Water vapor estimated pressures
- Runs in TeraScan® batch processing



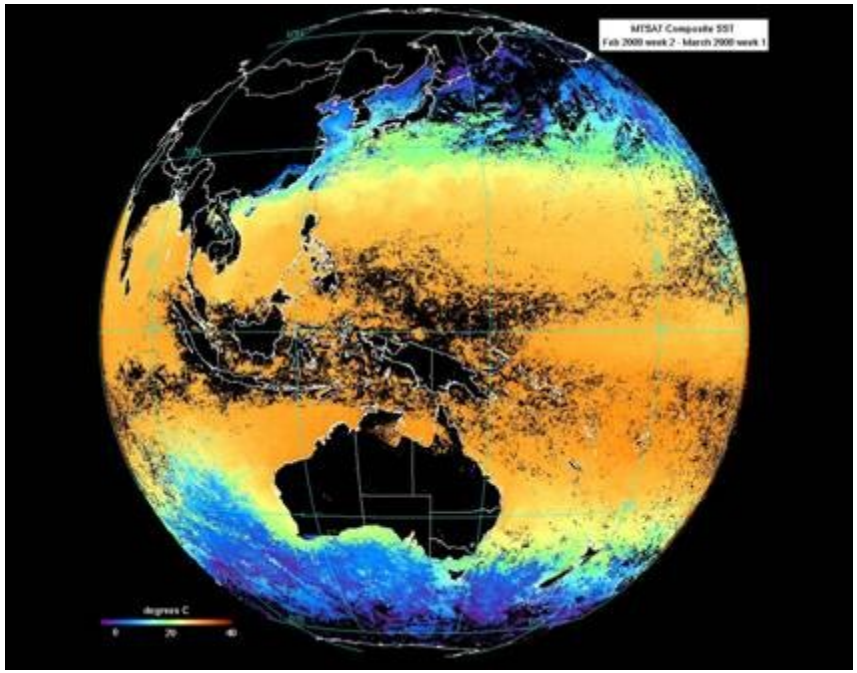
Fog Products

- New fog product added for Geostationary satellites
- Works in TeraScan® batch processing



SST Product

- SST generation from GOES, MSG and MTSAT added.
- Works in TeraScan® batch processing



TeraVision-II Improvements

- Upgraded pan and zoom
- Upgraded palette selection
- Improved organization of layers
- Upgraded contour function
- Implementation of layer time-matching for making animations

Current and Future Environmental Satellites

SeaSpace will support NPP and NPOESS missions. System upgrade will be available prior to launch.

IPOPP Processing Configuration

Raw MODIS Data

Quicklook

Internet

Send/Receive Pass

L0 Data

Processing System

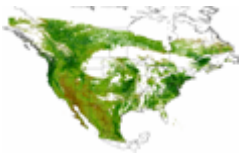
Status/Event Logging System (SLS)

Information Services (IS)

Control System (CS)

Data Storage Manager (DSM)

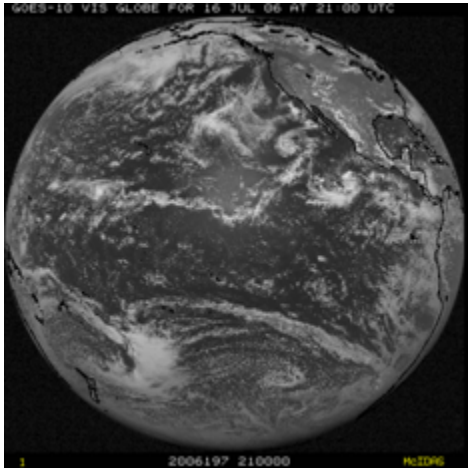
HDF2GeoTiff (H2G)

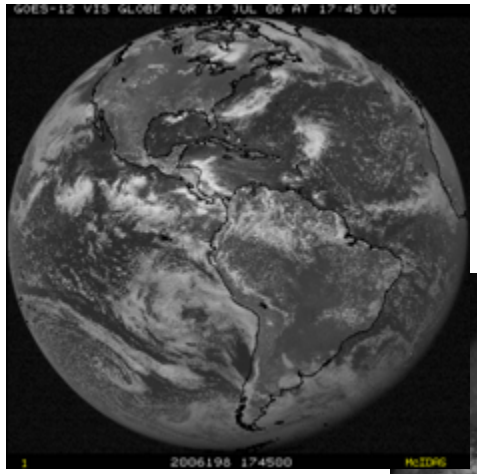


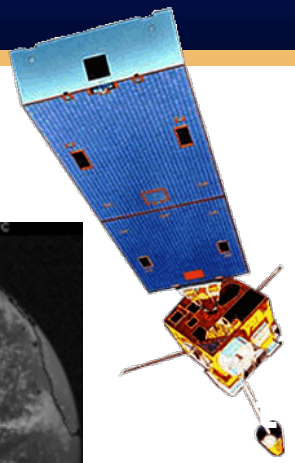
Science Processing Algorithms (SPA)

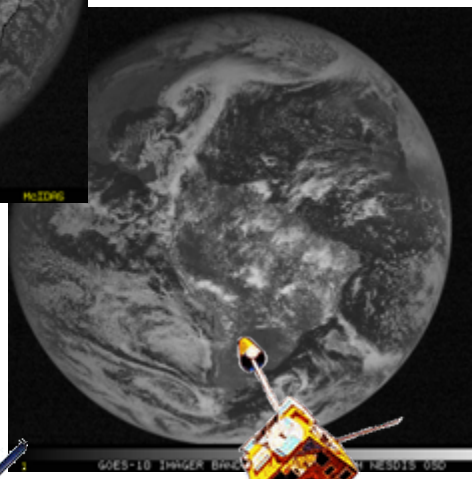
- **Fire Mask**
- **Vegetation Index**
- **Sea Surface Temperature (SST)**
- **Chlorophyll Concentration**
- **Cloud Mask**
- **Aerosol**
- **Cloud Top Properties**
- **Cloud Phase**
- **Atmospheric Profiles**
- **Land Surface Temperature (LST)**
- **Corrected Reflectance (CREFL)**
- **Other Products**

Current GOES Constellation

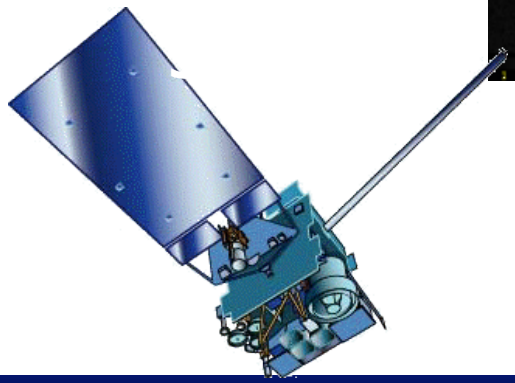


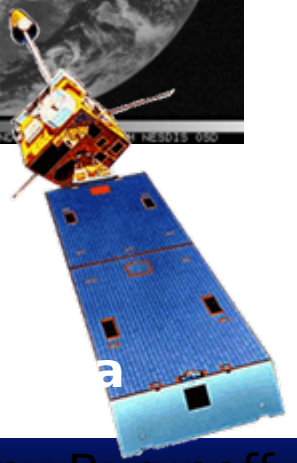






- GOES mission requires two on-orbit operational satellites and one on-orbit spare
- GOES-West location in GOES-R series to be 137°W instead of current 135°W

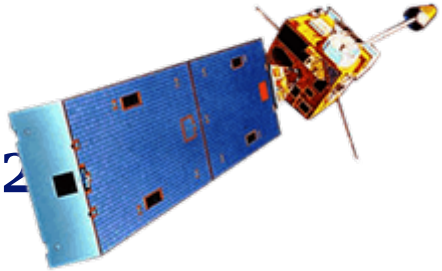


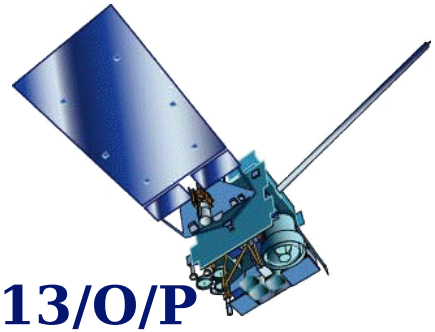


GOES-13

- GOES-13 launched 24 May 2006, currently supporting GOES-11 eclipse operations and will return to on orbit standby
- GOES-13/O/P have similar instruments to GOES-8-12, but are on a different spacecraft bus. The new bus allows improvements to the navigation, registration, and radiometrics.
- Spring and fall eclipse outages are avoided by on-board batteries.

GOES-8/12

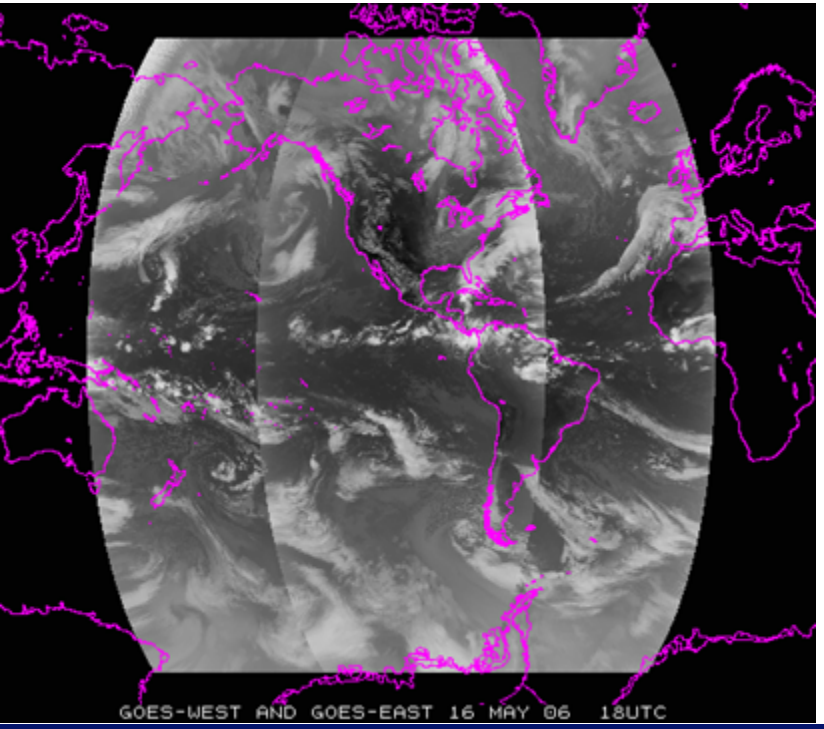




GOES-13/O/P

GOES-R: The Future

- GOES-R
- GOES-R series being developed to replace GOES-N series.
- First launch planned no earlier than 2014
- Significant improvement in technology over GOES-I and GOES-N series



- **Improvements over current capabilities**
- **Imager (ABI)**
  - Better resolution (4X), faster coverage (5X), more bands (3.2X) and more coverage simultaneously
- **Lightning detection (GLM)**
  - Continuous coverage of total lightning flash rate over land and water
- **Solar/Space Monitoring (SUVI, EXIS, SEISS)**
  - Better Imager (UV over X-Ray)
  - Better Heavy Ion detection, adds low energy electrons and protons
- **Unique Payload Services**
  - Higher Data Rates for Environmental Data Relay
  - Continued Search and Rescue

SeaSpace will support GOES-R

Increased Performance

Performance Capability	GOES I-M	GOES N-P	GOES R
Imaging			
Visible Resolution	1 km	1 km	0.5 km
IR Resolution	4-8 km	4-8 km N 4 km O/P	1-2 km
Full Disk Coverage Rate	30 min	30 min	5 min
#of Channels	5	5	16
Solar Monitoring	GOES-M only	Yes	Yes
Lightning Detection	No	No	Yes
Operate through Eclipse	No	Yes	Yes
Ground System Backup	Limited	Limited	Limited
Archive and Access	Limited	Limited	Yes
Raw Data Volume per spacecraft	2.6 Mbps	2.6 Mbps	75 Mbps

- **GOES-R maintains continuity of the GOES mission**
- **GOES-R also provides significant increases in spatial, spectral, and temporal resolution of products**

Increased Imaging Capability

GOES-I/P

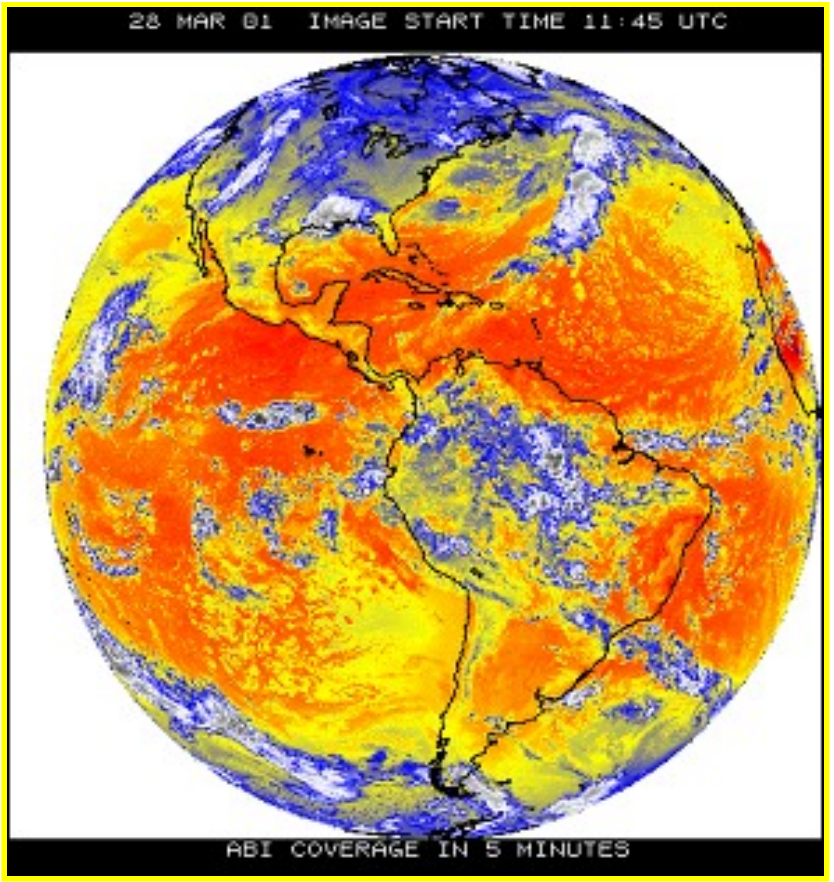
ABI Scan Modes

- **Mode 3: 15 minute cycle**
  - **1 Full Disk**
  - **3 CONUS**
  - **1000km x 1000km every 30 seconds**
- **Mode 4:**
  - **Continuous 5 minute**

Full Disk

1/5 Disk

GOES-R



Full Disk

ABI covers the earth approximately five times faster than the current

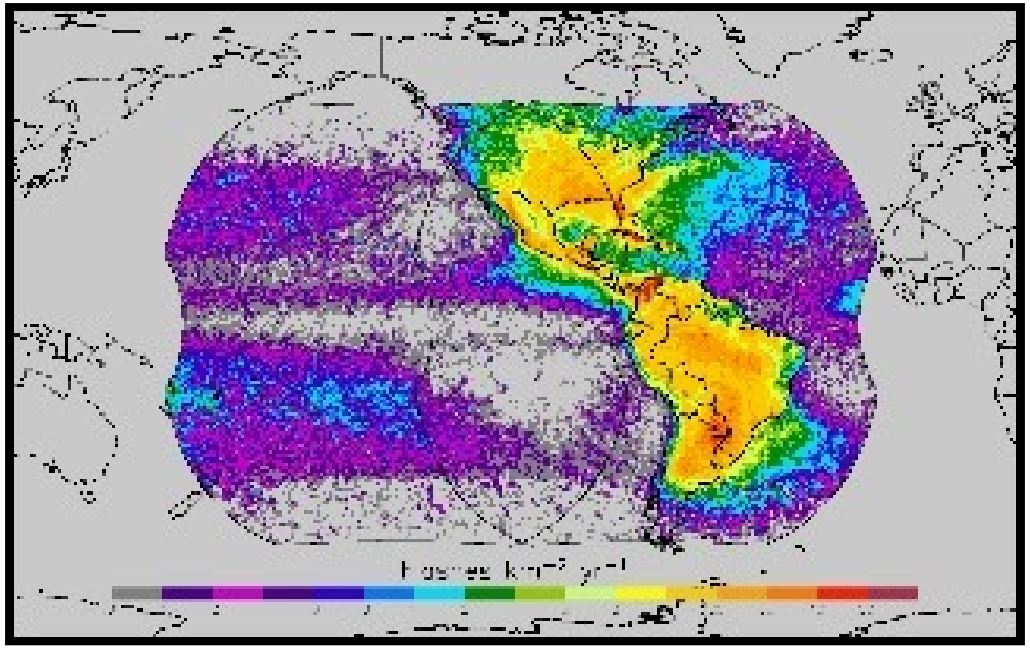
ABI Spectral Bands

Future GOES imager (ABI) band	Wavelength range (μm)	Central wavelength (μm)	Nominal subsatellite IGFOV (km)	Sample use
1	0.45–0.49	0.47	1	Daytime aerosol over land, coastal water mapping
2	0.59–0.69	0.64	0.5	Daytime clouds fog, insolation, winds
3	0.846–0.885	0.865	1	Daytime vegetation/burn scar and aerosol over water, winds
4	1.371–1.386	1.378	2	Daytime cirrus cloud
5	1.58–1.64	1.61	1	Daytime cloud-top phase and particle size, snow
6	2.225–2.275	2.25	2	Daytime land/cloud properties, particle size, vegetation, snow
7	3.80–4.00	3.90	2	Surface and cloud, fog at night, fire, winds
8	5.77–6.6	6.19	2	High-level atmospheric water vapor, winds, rainfall
9	6.75–7.15	6.95	2	Midlevel atmospheric water vapor, winds, rainfall
10	7.24–7.44	7.34	2	Lower-level water vapor, winds, and SO_2
11	8.3–8.7	8.5	2	Total water for stability, cloud phase, dust, SO_2 rainfall
12	9.42–9.8	9.61	2	Total ozone, turbulence, and winds
13	10.1–10.6	10.35	2	Surface and cloud
14	10.8–11.6	11.2	2	Imagery, SST, clouds, rainfall
15	11.8–12.8	12.3	2	Total water, ash, and SST
16	13.0–13.6	13.3	2	Air temperature, cloud heights and amounts

Geostationary Lightning Mapper (GLM)

- **Detects total strikes: in cloud, cloud to cloud, and cloud to ground**
  - **Complements today's land based systems that only measures cloud to ground (about 15% of the total lightning)**
- **Increased coverage over oceans and land**
  - **Currently no ocean coverage,**

n



Underlying lightning climatology courtesy of the NASA Lightning Imaging Sensor (LIS) Science Team, Huntsville, AL

GOES-R Communications Payload

SeaSpace will support the following:

- GOES Rebroadcast (GRB)
  - **Replacement of today's GVAR**
  - **Data rate of 31 Mbps in L-band**
    - **GVAR - 2.11 Mbps**
  - Low Rate Information Transmissions (LRIT)
  - Data Collection System (DCS)-in development

- EGVAR (Emulated GVAR)
  - **Transmission between GOES-N/O/P and GOES-R series**
  - **GVAR like data set consisting of GOES-R data**
  - **For transmission through existing GOES-N/O/P legacy system**

Planned GOES-R Products

Aerosol Detection (including Smoke and
Aerosol Particle Size
Suspended Matter / Optical Depth
Volcanic Ash *
Aircraft Icing Threat
Cloud Imagery: Coastal *
Cloud & Moisture Imagery
Cloud Layers / Heights & Thickness *
Cloud Ice Water Path *
Cloud Liquid Water
Cloud Optical Depth
Cloud Particle Size Distribution
Cloud Top Phase
Cloud Top Height *
Cloud Top Pressure *
Cloud Top Temperature *
Cloud Type
Convection Initiation
Enhanced "V" / Overshooting Top
Hurricane Intensity
Low Cloud & Fog
Lightning Detection
Turbulence
Visibility

Geomagnetic Field
Probability of Rainfall
Rainfall Potential
Rainfall Rate / QPE
Legacy Atm. Vertical Moisture
Legacy Atm. Vertical Temperature
Derived Stability Indices *
Total Precipitable Water *
Total Water Content *
Clear Sky Masks
Radiances *
Absorbed Shortwave Radiation:
Downward Longwave Radiation:
Downward Solar Insolation: Surface
Reflected Solar Insolation: TOA
*Upward Longwave Radiation *:*
*Upward Longwave Radiation *: TOA*
Ozone Total *
SO_2 Detection *
Derived Motion Winds *
Fire / Hot Spot Characterization
Flood / Standing Water
Land Surface (Skin) Temperature *

Surface Albedo
Surface Emissivity *
Vegetation Fraction: Green
Vegetation Index
Currents
Currents: Offshore
Sea & Lake Ice / Age
Sea & Lake Ice / Concentration
Sea & Lake Ice / Extent
Sea & Lake Ice / Motion
Ice Cover / Landlocked
Snow Cover
Snow Depth (Over Plains)
Sea Surface Temps
Energetic Heavy Ions
Mag Electrons & Protons: Low
Mag Electrons & Protons: Med &
Solar & Galactic Protons
Solar Flux: EUV
Solar Flux: X-Ray
Solar Imagery: X-Ray

ABI – Advanced Baseline Imager

Continuity of GOES Legacy Sounder Products from ABI

SEISS – Space Env. In-Situ Suite

EXIS – EUV and X-Ray Irradiance Sensors

GLM – Geostationary Lightning Mapper

Magnetometer

SUVI – Solar extreme UltraViolet Imager

SeaSpace Future

" Thank you for inviting us to your conference. SeaSpace looks forward to continuing our partnership with the Naval Maritime Forecast Center and the Joint Typhoon Warning Center. Having customers like you helps bring out the best in us."

-Hyong Ossi, President/CEO

Thank You